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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/067,866

02/08/2002

Shigetaka Aoki

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02/13/2003

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EXAMINER

GEBREMARIAM, SAMUEL A

ART UNIT

PAPER NUMBER

2811

DATE MAILED: 02/13/2003

4

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/067,866

Applicant(s)

AOKI, SHIGETAKA

Examiner

Samuel A Gebr mariam

Art Unit

2811

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 08 February 2002.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-10 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-10 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 2.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless --

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

Claims 1-4, 8, 9 and 10 are rejected under 35 U.S.C. 102(e) as being anticipated by Kondo et al. US patent No. 6,388,307.

Regarding claim 1, Kondo teaches (figs. 3, 4 and 9) semiconductor device, comprising: a substrate (1) having a first semiconductor layer (2, 3); a second semiconductor layer (13) provided on the first semiconductor layer, wherein the second semiconductor layer has a smaller band gap than the first semiconductor layer and is made of a mixed crystal semiconductor; and a third semiconductor layer (20), which is provided on the second semiconductor layer and has a larger band gap than the second semiconductor layer; wherein the semiconductor device functions as a heterojunction bipolar transistor in which at least a portion of the first semiconductor layer is a collector region including first conductive-type impurities (n-type); at least a portion of the second semiconductor layer is a base region including second conductive-type impurities (p-type); and at least a portion of the third semiconductor layer is an emitter region including the first conductive-type impurities (n-type); wherein the second semiconductor layer comprises a graded composition layer (see fig. 9, col. 7, line 50-67) having a composition in which the band gap becomes larger in a direction from the

collector region toward the emitter region, and a upper layer having a composition in which the band gap change ratio is smaller than the band gap change ratio of the graded composition layer; and an emitter-base junction is formed in the upper layer of the second semiconductor layer.

The increase in germanium concentration of the mixed crystal of Si and Ge results in the band gap increase in the direction from the collector region towards the emitter region. Therefore Kondo's structure inherently teaches the band gap becomes larger in a direction from the collector region toward the emitter region, and an upper layer having a composition in which the band gap change ratio is smaller than the band gap change ratio of the graded composition layer (see fig. 9).

Regarding claim 2, Kondo teaches the entire claimed structure of claim 1 above including the composition of the mixed crystal semiconductor in the upper layer of the second semiconductor layer is substantially constant, and the band gap in the upper layer is substantially constant (see fig. 9).

Regarding claim 3, Kondo teaches the entire claimed structure of claim 1 above including the composition of the mixed crystal semiconductor in the upper layer of the second semiconductor layer is substantially continuously changing, and the band gap of the upper layer changes to become larger in the direction from the collector region toward the emitter region (fig. 9).

Regarding claim 4, Kondo teaches (fig. 9) the entire claimed structure of claim 1 above including the second semiconductor layer has a band gap in its upper layer which increases in the direction from the collector region toward the emitter region, and further

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comprises a top layer, in which the band gap change ratio is larger than the band gap change ratio of the upper layer.

Regarding claim 8, Kondo teaches (fig. 9) the entire claimed structure of claim 1 above including the emitter-base junction is positioned substantially in the center of the upper layer of the second semiconductor layer.

Regarding claim 9, Kondo teaches (fig. 9) the entire claimed structure of claim 1 above including the impurity concentration in the graded composition layer of the second semiconductor layer decreases as the band gap increases in the direction from the collector region toward to the emitter region, and the impurity concentration in the upper layer of the second semiconductor layer is substantially constant.

Regarding claim 10, Kondo teaches (fig. 9) the entire claimed structure of claim 1 above including the second semiconductor layer is a SiGe layer, and the impurities in the second semiconductor layer are boron (B).

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 5 and 6, are rejected under 35 U.S.C. 103(a) as being unpatentable over Kondo et al. in view of Crabbe et al. US patent No. 5,352,912.

Regarding claims 5 and 6, Kondo teaches substantially the entire claimed structure of claim 1 above including the second semiconductor layer is a SiGe layer; the third semiconductor layer is a Si layer.

Kondo does not teach the Ge content in the upper layer of the second semiconductor layer is in a range of 2 to 8%, and changes not more than 4%.

Parameters such as concentration and depth in the art of semiconductor manufacturing process are subject to routine experimentation and optimization to achieve the desired device characteristics. Furthermore Crabbe teaches a graded profile of 5-23% Ge added to the base region of heterojunction bipolar transistor.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to adjust the Ge content in the SiGe layer as claimed in order to enhance the speed of the HBT.

Claim 7, is rejected under 35 U.S.C. 103(a) as being unpatentable over Kondo et al. in view of Croke et al. US patent No. 6,316,715.

Regarding claim 7, Kondo teaches substantially the entire claimed structure of claim 1 above including the third semiconductor layer is a Si layer.

Kondo does not teach the second semiconductor layer is a three-element mixed crystal semiconductor layer including carbon.

It is conventional and also taught by Croke to incorporate dope SiGe base with carbon (col. 1, line 43-61).

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It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate carbon in the SiGe base layer of Kondo's structure taught by Croke in order to limit the out diffusion of boron (col. 1, line 43-61).

Conclusion

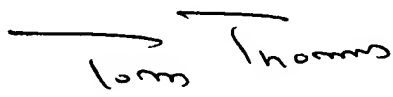
3. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. References D and E are cited as being related to HBT.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Samuel Admassu Gebremariam whose telephone number is 703 305 1913. The examiner can normally be reached on Monday-Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tom Thomas can be reached on 703-308-2772. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

Samuel Admassu Gebremariam
February 4, 2003


TOM THOMAS
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2700